AMENDMENT OF THE SPECIFICATION:

Please amend the Specification as follows:

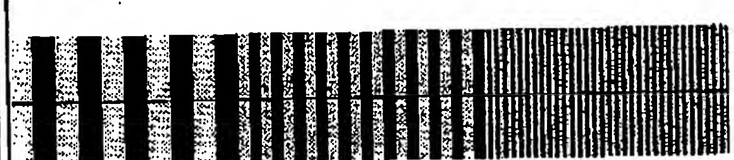
On Page 19, please amend the last paragraph as follows:

Fig. ~~4F3~~ 4E shows the 1.4 and 1.6 pixel sampling limits plotted on the same axes as the optical performance curve for a fixed focal length reader (as they are functions of object distance);

On Pages 45-48, please amend the Specification as follows:

The preferred criterion for designing the image formation optics in the system hereof is the modulation transfer function, or MTF. The MTF provides a measure of the contrast present in an object or image. Qualitatively, contrast may be thought of as the difference between light and dark regions in the object or image. The greater the difference in "brightness" between two regions of the object or image, the greater the contrast. ~~contrast, as illustrated in the figure below, where contrast increases from left to right:~~

Considering the image, given the data from the image sensor, a quantitative treatment is possible. On the common 8 bit scale, a pixel that is totally black is assigned the value 0, while a pixel that is totally saturated white is assigned the value 255. ~~Therefore, an image that appears like as follows~~



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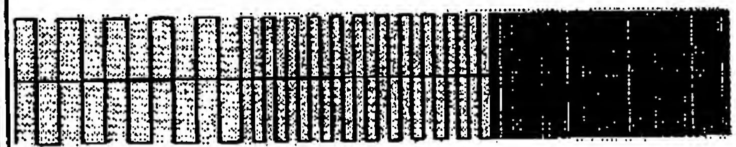
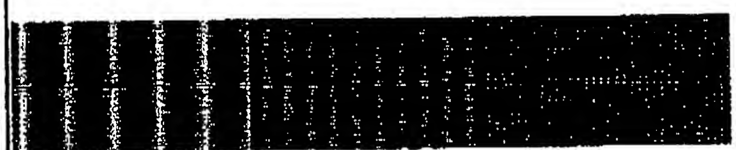
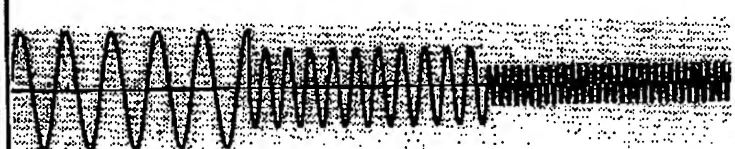
~~may also be represented by a plot of its pixel values, as follows:~~



~~If this were a representation of a target object, then the resulting image would be different. Namely, due to the various effects described above, the contrast would not be exactly preserved. In other words~~ Also, the closer the spacing of the object features, then the worse the reproduction of that contrast in the image of the object. ~~Therefore, the image of the object might appear something like the graphical representation set forth below:~~



~~and a plot of the values something like the following graphical representation:~~



A mathematical expression is required to quantify the amount of contrast present in an object or image, so that its variation after imaging through the optics may be assessed. A useful contrast measure can be defined as the modulation M of a given region in the object, given as follows:

$$M = \frac{\text{max value} - \text{min value}}{\text{max value} + \text{min value}}$$

The greater the contrast in the object or image, the greater the value of M, up to a maximum of 1. On the other hand, no contrast whatever in the object or image (i.e. no distinguishable features in

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the region of the object in question) yields a modulation of 0. To determine how well the image formation optics preserves the modulation of the target object in the image, it is only necessary to form a ratio of the image modulation to the object modulation, which is the MTF:

$$\mathrm{MTF} = \frac{\text{image modulation}}{\text{object modulation}}$$

Perfect reproduction of the object contrast in the image (impossible in practice) results in an MTF of 1. A total loss of the object contrast in the image gives an MTF of 0.

The MTF is a useful concept in optical design because it simultaneously accounts for the impact of any effect that degrades the quality of the image, usually referred to as blurring. As described previously, these effects include diffraction, aberrations (spherical, chromatic, coma, astigmatism, field curvature) and deviation of the object distance from its nominal value. It should be mentioned for sake of completeness, however, that MTF is not a single perfect or all-encompassing measure of image quality. One potential drawback is that examining the MTF reveals only the total impact of all effects simultaneously, and cannot distinguish between blurring caused by one defect or another. If it is necessary to determine what effects are degrading the MTF, and to what extent for each, then other methods must be used, and other criteria examined. In addition, there are potentially negative image characteristics, such as distortion, that are not revealed at all by the MTF. If the optical designer is not careful, then it is possible that an image with an MTF close to the diffraction limit, which is as good as it is possible to get, may have distortion so bad that it is unusable in the application at hand.

In accordance with the design method of the present invention, after calculating the MTF for a given optical design, an additional criterion is necessary to specify what MTF is good enough for the application in question. For bar code decoding applications, a useful rule of thumb is that 0.3 MTF or better is needed for decoding software to work reliably well in an Imaging-Based Bar Code Symbol Reader. The design strategy employed on the Imaging-Based Bar Code Symbol Reader of the present invention is to determine, as a function of object distance, the code element size (in millimeters) at which the MTF of the resulting image falls to 0.3. In other words, at each object distance, the optical designer should determine what is the smallest size of code element

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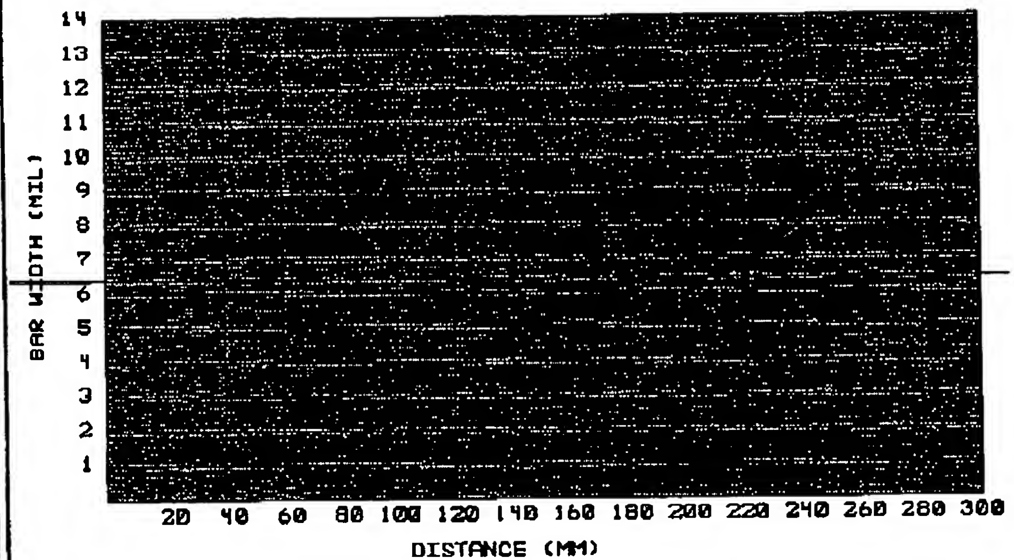
(in millimeters) that can be imaged well enough to be read by the Multi-Mode Image-Processing Bar Code Reading Subsystem 17 of the present invention. At one stage of the design of the image formation optics employed in the illustrative embodiment, the plot of minimum code element size against object distance is generated, as shown in Fig. 4E. ~~appeared as shown below:~~



Given such a plot, the optical design team needs to determine whether or not the resulting bar code reader performance satisfies the requirements of the application at hand. To help make this determination, an advanced optical design method and tool described below can be used with excellent results.

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